

the high impurity concentration in the aforementioned first to third embodiments, the present invention is not restricted to this but the interface of the emitter layer with the emitter barrier layer may be alternatively formed by an alloy or silicide having a work function coincident with a bottom of the conductive band of silicon. Alternatively, the interface of the emitter layer with the emitter barrier layer may be formed by semiconductor such as SiC, having an electron affinity smaller than Si. In this case, also when an oxide having a dielectric constant smaller than that of TiO₂ is employed as the emitter barrier layer, the oxide is unlikely to become a potential barrier to electrons and is likely to feed a current.

[0075] While the plugs 108a, 108b, 111a, 111b and 114a to 114e are embedded in the contact holes 107a, 107b, 110a, 110b and 113a to 113e in the aforementioned second embodiment, the present invention is not restricted to this but barrier metal layers made of Ti, having higher electric conductivity and capable of inhibiting the plugs from diffusing in the interlayer dielectric films may be alternatively formed on inner peripheral surfaces of the contact holes and the plugs may be alternatively formed in the contact holes through the barrier metal layers.

[0076] While the semiconductor device including the hot electron transistor shown in the first embodiment is shown in the aforementioned second embodiment, the present invention is not restricted to this but the hot electron transistor shown in the third embodiment may be applied to the semiconductor device according to the second embodiment.

[0077] While the base side emitter layer, the emitter side emitter layer and the collector layer are formed by TiN in the aforementioned third embodiment, the present invention is not restricted to this but the collector side base layer, the emitter side base layer and the collector layer may be alternatively formed by other metal nitride such as TaN.

What is claimed is:

1. A hot electron transistor comprising:

a collector layer;

a base layer;

an emitter layer;

a collector barrier layer formed between said collector layer and said base layer; and

an emitter barrier layer formed between said base layer and said emitter layer, wherein

an energy barrier between said emitter barrier layer and said emitter layer does not substantially exist and the height of an energy barrier of said collector barrier layer is lower than the height of an energy barrier of said emitter barrier layer.

2. The hot electron transistor according to claim 1, wherein said base layer is made of a metal nitride.

3. The hot electron transistor according to claim 1, wherein said base layer contains nitrogen atoms, and said base layer is formed such that the nitrogen atom concentration on a side of said collector layer is higher than the nitrogen atom concentration on a side of said emitter layer.

4. The hot electron transistor according to claim 3, wherein said base layer includes a first base layer and a second base layer, said first base layer is formed on the side of said collector layer and has a first nitrogen atom concentration, and said second base layer is formed on the side of said emitter layer and has a second nitrogen atom concentration lower than said first nitrogen atom concentration.

5. The hot electron transistor according to claim 1, wherein said collector barrier layer and said emitter barrier layer are made of the same metal oxide.

6. The hot electron transistor according to claim 1, wherein an interface of said emitter layer with said emitter barrier layer is made of either silicon or a metal nitride.

7. The hot electron transistor according to claim 1, wherein an interface of said emitter barrier layer with said emitter layer and an interface of said emitter barrier layer with said base layer are made of materials having different energy barrier heights respectively.

8. The hot electron transistor according to claim 7, wherein said emitter barrier layer and said collector barrier layer are made of the same material, and the interface of said emitter barrier layer with said emitter layer and said collector barrier layer have the same crystal structure.

9. The hot electron transistor according to claim 7, wherein the interface of said emitter barrier layer with said emitter layer and the interface of said emitter barrier layer with said base layer have different crystal structures respectively.

10. The hot electron transistor according to claim 1, wherein

said base layer is made of TiN and said emitter barrier layer and said collector barrier layer are made of an oxide of Ti.

11. A semiconductor device comprising:

a substrate;

a transistor formed on said substrate;

an interlayer dielectric film so formed on a surface of said substrate as to cover said transistor; and

a hot electron transistor formed on a surface of said interlayer dielectric film, wherein

said hot electron transistor includes a collector layer, a base layer, an emitter layer, a collector barrier layer formed between said collector layer and said base layer and an emitter barrier layer formed between said base layer and said emitter layer, and

an energy barrier between said emitter barrier layer and said emitter layer does not substantially exist and the height of an energy barrier on an interface between said base layer and said collector barrier layer viewed from Fermi energy of said base layer is smaller than the height of an energy barrier on an interface between said base layer and said emitter barrier layer.

12. The semiconductor device according to claim 11, wherein

said base layer of said hot electron transistor is made of a metal nitride.

13. The semiconductor device according to claim 11, wherein

said base layer of said hot electron transistor contains nitrogen atoms, and

said base layer is formed such that the nitrogen atom concentration on a side of said collector layer is higher than the nitrogen atom concentration on a side of said emitter layer.

14. The semiconductor device according to claim 13, wherein

said base layer of said hot electron transistor includes a first base layer and a second base layer,

said first base layer is formed on the side of said collector layer and has a first nitrogen atom concentration, and